Interactions between Free-living Soil Nematodes and Ryegrass: Effects on Nitrogen Mineralization

Gebremikael, M.T.[a], Buchan, D.[a], De Neve, S.[a],
[a]Department of Soil Management, Faculty of Bioscience Engineering, Gent University, Gent, Belgium

1. Background & Objectives

Free-living nematodes have been estimated to contribute 8-19% to total N mineralization in soil (Neher and Power, 2005). These results are based on theoretical food web calculations (Hunt et al., 1987) or very simplified experiments including only a few selected species, often on sterilized media (Ferris et al., 1998). However, N mineralization is controlled by biological interactions between microbes, fauna and plants. To address this issue we conducted an incubation experiment with and without plants, by re-inoculating entire nematode populations into soil cores that had been defaunated using low-dose gamma irradiation which selectively kills fauna while minimally disturbing the microbial population. The objective of this experiment was to investigate the effect of interactions among different feeding groups of free-living soil nematodes, microbes and plants on nitrogen mineralization.

2. Materials & Methods

Part of the fresh soil samples collected were gamma irradiated at a 5 kGy dose in order to kill nematodes and other soil fauna. Entire populations of free-living nematodes were extracted from bulk soil using an automated zonal centrifugal machine (Hendrickx, G. 1995) and re-inoculated into cores that had been filled with defaunated soil. Three treatments, each with four replicates, were compared on soil either left bare or planted with *Lolium perenne*: (i) not irradiated and not inoculated (control) which mainly used for comparing nematode population and dynamics, (ii) defaunated and reinoculated (+Nem), and (iii) defaunated but not re-inoculated (-Nem). The moisture content was adjusted to 50% of the water filled pore space and kept constant by adding distilled water every day. Dynamics of mineral N in soil, plant N uptake, microbial biomass carbon (MBC), and nematode population were determined destructively after 7, 30, 45, 65, and 86 days of incubation in a growth chamber (17$_o$C and 16/8 light/dark hours). Due to the influence of plant uptake on N dynamics in planted microcosms, total mineral N was considered as the sum of mineral N that was found in the soil and taken up by the grass shoots and roots. Two way ANOVA, with two fixed factors: time versus treatment; and palnting versus treatment were separately run to analyze all the parameters and palnt-nematode interactions respectively. Whenever there was significant mean differences ($P<0.05$), Games-Howel post hoc analysis was used in SPSS version 19.

3. Results & Discussion

The nematodes population after reinoculation was compared to the control in order to check the efficiency of re-inoculation. At the beginning of incubation the efficiency was found to be 67.4% and 49.5% in bare and planted microcosms respectively. But after 65 days of incubation, the population was found to be higher ($P<0.05$) in +Nem samples than the control in planted microcosms. Total mineral N in bare microcosms was found to be significantly ($P<0.05$) higher in +Nem samples as compared to –Nem samples (Figure 1). Similarly NO_3-N concentration was found to be significantly ($P<0.05$) higher in +Nem samples towards the end of the incubation period. Xiao et al. (2010) reported that bacterial feeding nematodes increased ammonia-oxidizing bacterial community which could explain the increased nitrate concentrations. In contrast to bare Nitrogen Workshop 2012 microcosms, no significant difference ($p>0.05$) in total mineral N was found between +Nem samples and –Nem samples in planted microcosms (Figure 1). Plant versus treatment interactions were found statistically significant ($p<0.05$) for –Nem samples.

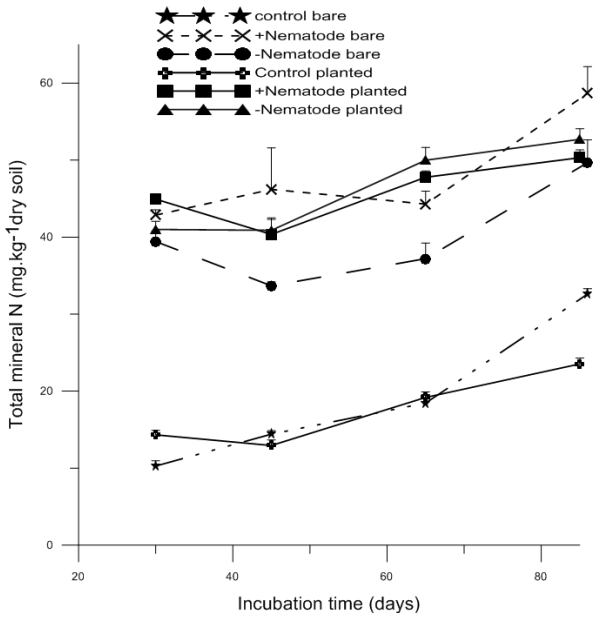

Figure 1. Dynamics of total mineral N over the incubation period. The error bars are standard error of the mean (n=4).

Previous investigations reporting increased plant N uptake used only few species of nematodes under sterilized conditions (Ingham et al., 1985). Here, inoculating the entire nematode population instead of few species, which normally consist of plant parasitic nematodes, might have affected N uptake in plants. Data on the composition of the microbial and nematode populations and enzymatic activities is currently being processed.

4. Conclusion

Free-living soil nematodes communities can increase nitrification and N mineralization in bare microcosms. The results show that the presence of the entire free living nematodes did not significantly affect total mineral N in the planted microcosms. Data on the functional feeding groups of these nematodes is required to possibly explain the mechanism responsible for the effects of nematodes on N mineralization and plant uptake.

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